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1930 PROGRESS REPORT
ON THE STUDY OF THE RELATION OF FIRE INJURY TO
BARKBEETLE ATTACK IN YELLOW PINE
(Tubb's Hill Burn)

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RELATION OF FIRE INJURY TO BARKBEETLE ATTACK IN YELLOW PINE
(TODD'S HILL BURN)*

Forest fires, particularly those occurring in white and yellow pine stands, have been credited with causing a temporary increase of barkbeetle damage. The type known as "light" or ground fire greatly increases the number of trees susceptible to barkbeetle attack. Many of these trees that are only slightly injured by the fire, and would possibly recover, are selected and killed by the attacks of various species of woodborers. Numerous questions in regard to the attraction value of certain classes of fire injured trees, their ultimate recovery if not attacked by barkbeetles, and the rise and decline of insect infestations on burned areas, still remain unanswered, and it is only through intensive studies of such problems that the answers can be found.**

An exceptional opportunity to study the relation of fire injury and barkbeetle attack in yellow pine in this locality was made possible by the occurrence of a ground fire on the south slope of Todd's Hill.

* Preliminary Report, Todd's Hill Burn July 18, 1939, H. J. Rust.
1939 Progress Report Todd's Hill Burn, H. J. Rust.

** J. M. Miller, J. E. Patterson, Preliminary Studies of the Relation of Fire Injury to Barkbeetle Attack in Western Yellow Pine, J. A. Research Vol. 7, #7.

TURB'S HILL BURN

On September 22, 1928, a fire of incendiary origin was discovered on the south slope of Turb's Hill. Immediate action was taken to fight the fire, and it was placed under control in a few hours time after burning over thirty acres of an almost pure yellow pine stand. The area burned consists of about one-half of the southern slope of the hill. The fire originated in an old abandoned building near the shore of the lake at an elevation of 2124 feet, and spread to an elevation of 2400 feet before being placed under control. As this portion of the hill had been free from fire for a number of years, considerable undergrowth was present, consisting of buckbrush, acorn spray, ninebark, serviceberry, chokecherry and syringa. The duff that had accumulated on the slope consisted mostly of yellow pine needles and dead grass littered with pine cones and twigs. The surface of the area is very irregular owing to numerous large granite boulders and small ravines. These irregularities along with the steepness of the slope caused a fire of varying degrees of severity from a light ground fire where the stand was open, to a heavy crown fire where the growth was young and dense in the small ravines. All of the undergrowth on the area was destroyed as well as a large per cent of the yellow pine reproduction. A few of the larger defective yellow pine were burned through at the base and partly consumed after falling.

STUDIES OF AREA PRECEDING FIRE

From the years 1917 to 1928 this area (locally known as Tubb's Hill) had been used by the ~~Cosum~~ ^{Si} Leone Forest Insect Field Station as one of five check areas for intensive study of the annual insect losses caused by the western pine beetle, the spruce, and woodborers; no trees ever having been found on the hill prior to the 1928 fire that were killed by the mountain pine beetle.

YEARLY LOSS ESTIMATE OBTAINED BY A 100 PER CENT SURVEY

In initiating this study of the relation of fire injury to insect attack, a preliminary estimate of the loss on the Tubb's hill burn was obtained by making a 100 per cent survey between the dates of October 22 and November 23, 1928. As a basis for future study of insect losses, all the trees on the burn from six inches D.B.H. and over were marked with a small blaze and a numbered metal tag. A data sheet was made out for each marked tree, recording crown and bole development based on Dunning's Tree Classification, the degree of fire injury to the crown and root collar, and any evidence of insect attack. An increment core was also taken from each tree for information on the rate of growth. The small trees from six to ten inches D.B.H. were marked and recorded to determine the class of fire injury offering the most suitable host for the various species of secondary barkbeetles and woodborers.

For the year 1929, a 100 per cent survey of the burn was made by the writer between the dates of August 26 and September 10, and the foliage conditions and all insect losses for the numbered trees were recorded. This survey was again made for 1930 between the dates of September 3 and 10.

CLASSIFICATION OF FIRE DAMAGE

The classification of the various degrees of fire injury to the crown as used by the Palo Alto California Station, which would seem to justify standardization, has been followed in classifying the degrees of burn on the Tubb's Hill fire.

Classes of Fire Injury

- I No visible fire injury.
- II Up to 25 per cent of crown defoliated.
- III 25 to 50 per cent " " "
- IV 50 to 75 per cent " " "
- V 75 to 100 per cent of crown defoliated but with terminal buds and cambium green.
- VI 100 per cent defoliation, cambium severely injured, terminal buds killed.

Types of Burn on Tubb's Hill Area 1928

- 1 No fire injury. All trees in Class I. No trees of this class were found within the boundary of the burn.
- 2 Light ground fire; practically no standing trees killed; damage represented by Class II and III, comprising 94.2 per cent of the stand.
- 3 Medium fire damage represented by Classes IV and V, comprising 28 per cent of the stand.
- 4 Severe crown fire represented by Class VI, comprising 17.8 per cent of the stand.

The following additional classification of fire injury based on the per cent of root collar injury has been formulated at the Coeur d'Alene Station and used on the Tubb's Hill burn.

Classes of Fire Injury to Root Collar

- I No visible fire injury
- II Up to 25 per cent of root collar damaged.
- III 25 to 50 per cent " " " "
- IV 50 to 75 per cent " " " "
- V 75 to 100 " " " "
- VI 100 per cent of root collar damaged.

The prolonged burning of the accumulation of duff at the base on the uphill side of yellow pines growing on steep slopes often causes severe fire injury to the root collar, in some instances burning the base to such an extent as to cause trees to fall.

To determine the extent per cent of root collar injury requires the removal of a small band of bark at the surface of the ground around the entire hole and measuring the circumference and per cent of fire injury. This data can only be secured from trees after they have been heavily attacked by barkbeetles or woodborers; otherwise, girdling the fire scorched trees might result in the death of many that possibly would survive the effects of the burn. The preliminary classification of root collar damage to the fire injured trees other than those heavily attacked by barkbeetles was based on the outward appearance, the per cent of injury judged by the visible area of the root collar scorched. The examination of the root collar on barkbeetle attacked trees also gives some idea whether the insects or fire would be considered the primary cause of the death of the tree.

ACREAGE OF FIRE BY TYPE OF BURN

Owing to the small acreage burned and the various types being so intermingled, no attempt was made to estimate the acreage of each type.

Total acreage of burn - 30 acres
Stand of timber yellow pine - 98.4%
" " " Douglas Fir - 1.6%
Average stand B.F. per acre - 2985.3
Total volume B.F. for entire burn - 89,560

YELLOW PINE ON TURN'S HILL BURN
CLASSIFIED ACCORDING TO FIRE INJURY TO CROWN

Table 1

1924	No. of trees	Percent	Total Vol.	Ave. Vol.	Per cent of Vol.
Class I	0	0	0	0	0
Class II	397	37.8	53060	133	59.2
Class III	173	16.4	15150	86	17.0
Class IV	111	10.5	6390	57	7.0
Class V	185	17.5	9660	52	10.8
Class VI	187	17.8	5300	28	6.0
Totals	1053	100.0	89560		100.0

From a silvicultural or lumbering viewpoint requiring a thrift or cutting class, the trees on the Turn's Hill burn have been also arranged according to Dunning's Tree Classification, which follows in Table 2.

YELLOW PINE ON TURN'S HILL BURN
ARRANGED ACCORDING TO DUNNING'S TREE CLASSIFICATION
with no consideration to fire injury

Table 2

1924	No. of trees	Percent	Total Vol.	Ave. Vol.	Per cent of Vol.
Class I	4	1.0	1990	497.5	2.8
Class II	47	11.7	8180	173.4	10.
Class III	50	12.4	22120	442.4	26.1
Class IV	88	21.9	39010	443.2	46.1
Class V	1	3	1040	1040.	2.
Class VI	205	51.0	10700	52.1	12.6
Class VII	7	1.7	720	102.8	.8
Totals	402	100.0	84560		100.0

Small Y.P.					
No. volume	585				
Douglas					
Fir	66		4900		
Totals	1053		89560		100.0

A large per cent of the mature yellow pine comprising Classes II and III fire injury to crown (Table 1) and Classes 1, 3, 4, and 5, Dunning's Tree Classification (Table 2) were injured mainly by a ground fire. Many of these trees were heavily infected by mistletoe resulting in large witch brooms, particularly on the lower crown. In some instances these brooms with their accumulation of pine needles caught fire from the ground flames and caused various degrees of injury to the lower crowns. These trees were also subject to varying degrees of root collar injury. Trees from ten to twelve inches D.B.H. in Classes IV and V fire injury to crown (Table 1) and Classes 2 and 6 Dunning's Tree Classification (Table 2) were more concentrated in and at the heads of the small ravines and suffered severe crown injury as well as injury to root collar. Most of the trees in Class VI fire injury to crown (Table 1) were young and thin, and growing in dense stands near the heads of the small ravines. The greatest loss in number of trees occurred in diameters under ten inches. The loss from trees burned through at the base sufficiently to cause them to fall was slight, only fire being recorded at the time of the preliminary examination.

INSECT LOSSES WITHIN THE BURNED AREA

Coming to the lateness of the season when the fire occurred, (September 22) thoughts of barkbeetle flights and attacks would hardly be considered, but the 100 per cent survey of the burn that same year showed that 17 of the larger fire scorched yellow pine had been heavily attacked by the mountain pine beetle, and at the time of examination, eggs and young larvae were present. Fifty-nine other fire damaged yellow

pine with a total volume of 25,410 B.V. were found to be lightly attacked at the base by Dendroctonus monticolae at the time the trees were marked. Later examinations of the burn showed the light attacks on the 53 yellow pine to be ineffective in causing the death of the trees.

Prior to the 1928 fire no extensive losses by the mountain pine beetle in yellow pine in the vicinity of Coeur d'Alene had been recorded at this station. Dendroctonus monticolae infestations in white pine on the Coeur d'Alene National Forest, 26 miles distant, which have been in progress for a number of years past are the nearest known. It is believed that the attacking beetles on the Tubb's Hill burn emerged from white pine logs that had been hauled by rail from the forest, unloaded from a pier on the lake, and stored in large booms nearby, along the shore at the base of Tubb's Hill. No examination was made of the logs in 1928, but in 1929, large numbers of white pine logs were again stored along the shore as in 1928. On September 19, 1929, an examination was made of the stored logs, and it was found that a number of these contained heavy broods of the mountain pine beetle in the part above water. The brood in these logs was estimated to be 15 per cent new adults, 35 per cent pupae, and 50 per cent larvae, which were mostly in the prepupal stage. A slight emergence had already taken place, the attacking beetles selecting the tops of logs nearby. Following the fire, the freshly scorched trees on Tubb's Hill probably proved the most attractive to the beetles emerging from the logs in the boom.

WESTERN YELLOW PINE (TURN'S HILL BURN) ATTACKED BY DENDROCTENUS RENTICOLLAE
ARRANGED ACCORDING TO YEAR OF ATTACK, FIRE INJURY TO CROWN AND ROOT COLLAR, AND
BURNING'S TREE CLASSIFICATION

Table 3

Year	No. of Trees	Vol. B.F.	Fire Injury to Crown					Fire Injury to Root Collar					Burning's Tree Classification						
			Class					Class					Class						
			II	III	IV	V	VI	II	III	IV	V	VI	1	2	3	4	5	6	7
1928	17	7600	6	2	3	1	5	1	2	5	3	6	0	3	4	5	0	4	
1929	1	30	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
1930	3	30	0	1	0	2	0	1	0	1	1	0	0	0	0	0	0	3	
Totals	21	7660	6	4	3	3	5	2	2	6	5	6	0	3	4	5	0	8	

A comparison of the yellow pine selected for attack by Dendroctonus renticollae immediately following the fire classified according to injury both to the crown and root collar (Table 3) shows that there are six trees under Class II injury to crown as compared with one tree under Class II root collar injury. The remaining five of these trees, while showing but a slight loss to the foliage, were severely scorched at the base from the burning of the accumulated duff and have been distributed among the classes of greater degrees of injury to the root collar. No definite class of fire injury either to the crown or root collar seemed attractive to the beetles in 1928 for as shown in Table 3 all classes in both types of injury were selected for attack.

The 1928 attacked trees arranged according to Burning's Classification (Table 3) shows practically 60% of the beetle selection falling in Classes 3 and 4; Class 4 sustaining the greatest loss. In examining the 1928 attacked trees after emergence had taken place, it was found that on an average for the 17 trees, a normal brood had developed and emerged. The mountain pine beetle infestation on the burn, however, diminished to almost nothing for the second year, and very low for the third year; only four small yellow pine being attacked for the two years following the fire.

WESTERN YELLOW PINE (TUBB'S HILL BURN) ATTACKED BY DENDROCTONUS BREVICORNIS
ARRANGED ACCORDING TO YEAR OF ATTACK, CLASS OF FIRE INJURY TO CROWN AND ROOT COLLAR,
AND DUNNING'S TREE CLASSIFICATION

Table 4

Year	No. of Trees	Vol. B.F.	Avg. Vol. B.F.	Fire Injury to Crown						Fire Injury to Root Collar						Dunning's Tree Classification						
				Class						Class						Class						
				II	III	IV	V	VI		II	III	IV	V	VI		1	2	3	4	5	6	7
1928	3	1720	573							Attacked prior to fire								1	2			
1929	20	2740	137	5	2	3	6	4	2	3	7	7	1			0	1	1	1	0	14	1
1930	10	940	94	1	2	0	7	0	1	5	1	3	1	0		0	0	1	1	0	6	0
Totals 1929-30	30	3660	191	6	4	3	13	4	7	4	10	8	1			0	1	2	2	0	22	1

A comparison of the attacks by the western pine beetle for the three years (Table 4) on the burned area shows an increase of 567 per cent in number of trees attacked the first year after the fire. The second year (1930) after the fire shows an increase over 1928 of but 233 per cent or a decrease of 50 per cent from the previous year.

The year following the fire, the western pine beetles were present in greater numbers and selected the larger yellow pine that had been severely fire damaged. Half of the trees attacked had been badly scorched in the crowns (Table 4) and 70 per cent of the selected trees suffered root collar injury (Table 4) probably sufficient to cause the death of the trees irrespective of the insect attack. As the infestation began to decrease in 1930, the yellow pine selected for that year averaged less than half the size of those attacked the previous year. The selection, however, still remained with trees that had suffered severe injury to the crowns (Table 4).

According to Dunning's Tree Classification, Class 6 suffered the greatest loss from the western pine beetle during the two years following the fire, while Class 4 had two of the three attacked trees in 1928 prior to the fire. The number of trees attacked by the western pine beetle for 1930 was probably somewhat lessened from the fact that fifty-one square feet of infected bark containing larvae was taken from three P. brevicauda attacked trees, and used for a bark analysis experiment. The total emergence from this removed bark amounted to 13,674 adult beetles, or an average increase of 1091 per cent assuming that the number of parent adults attacking equalled two per square foot of bark. Based on this same assumption, enough beetles emerged from the 50 square feet of bark to successfully attack 500 square feet or approximately four yellow pine of the type selected for attack by this species in 1930.

WESTERN YELLOW PINE (TURNER'S HILL MASS.) ATTACKED BY IPA GREGGII
ARRANGED ACCORDING TO YEAR OF ATTACK, INJURY TO CROWN AND ROOT COLLAR

Table 5

Year	No. of Trees	Vol. D.B.H.	Fire Injury to Crown					Fire Injury to Root Collar				
			II	III	IV	V	VI	II	III	IV	V	VI
1928	5	0						Attacked prior to fire				
1929	71*	0	0	4	4	22	41	15	16	6	13	21
1930	28	0	3	2	3	20	0	15	5	4	3	1
Totals	99	0	3	6	7	42	41	30	21	10	16	22

* 50 additional yellow pine under 6 inches D.B.H.

The number of trees attacked by Ipa greggii increased to a large per cent during the season following the fire, being found in 127 of the small yellow pine, 71 of which were six inches D.B.H. and had been tagged and recorded. Fifty-eight per cent of the trees selected for attack in 1929, fell in Class VI injury to crown (Table 5) and are considered as killed from the effects of the fire. The remaining 42 per cent attacked were sufficiently fire damaged both to crown and root collar (Table 5) as to make their recovery from fire very doubtful.

The second year (1930) after the fire showed a rapid decline in the number of trees attacked, the average selection, however, continuing to be the most severely crown injured (Table 5) trees of the smaller diameter left on the burn.

WESTERN YELLOW PINE (TURNER'S HILL MASS.) ATTACKED BY
WOODBORERS

Woodborers, both Cerambycidae and Buprestidae are present in large numbers on the burn, but no direct loss can be accredited to them at this time, as their attacks are confined to trees attacked by the Dendroctonus species and Ipa greggii.

DEVELOPMENT OF BROODS IN FIRE INJURED TREES

There were three yellow pine trees infested with broods of the western pine beetle, standing within the burn at the time that the fire occurred. The broods in these trees consisted mainly of half grown larvae in the outer bark. These three trees were scorched to a slight extent around the bases from the effects of a ground fire, but with apparently no loss to the brood above the scorched area. One of the above mentioned trees contained a volume of 1600 B.V. and was heavily attacked and killed by the western pine beetle. Woodpeckers started working on this tree shortly after the fire occurred and by spring the outer bark was nearly all stripped from the tree. It is believed that 65 per cent of the Pedunculatus brevicauda larvae were eaten by the woodpeckers. While the emergence from the other two trees was apparently normal and could account for a number of the trees attacked in 1929, it is thought that some of the attacking beetles came into the burn from other areas.

BARK ANALYSIS FROM PEDUNCULATUS BREVICAUDA TREES (TURNER'S HILL BURN)

In order to secure some information on the ratio of attack to emergence of Pedunculatus brevicauda, samples of bark were taken from three yellow pine attacked in 1929. A total of fifty-one square feet was secured and placed in galvanized iron containers provided with a tight fitting cover with a small screened ventilation hole in the center. The bottom of the container was tapered to a small opening in center to fit over a glass jar containing water. As emergence took place the insects would pass through opening in bottom and be collected from water in jar. The bark was taken from brood with overwintering generation and was placed in containers on April 9, 1929, emergence taking place during July, 1930.

The following calculations show the D. brevicornis emergence and also that of the more numerous associated insects:

DENDROCTOMUS BREVICORNIS

Table 6

Tree No.	No. of sq. ft. bark	Total Attacks	Avg. per sq. ft.	Total	Avg. per sq. ft.	Total emergence	Avg. emergence per sq. ft.	Ratio of attacks to emergence	Per cent of increase
207	20	203	10.1	265	13.25	4593	229.6	1 : 11.3	1031
550	15	195	13.0	280	18.6	5763	384.1	1 : 14.8	1377
939	16	176	11.0	243	15.2	1320	207.5	1 : 9.4	285
Grand Total	51	574	11.1	788	15.4	13676	821.2	1 : 35.5	3174
Average	17	191	11.4	262.6	15.7	4558	273.7	1 : 11.9	1091

* Assumed number of parent adults per attack equals two.

Tree No. 207 was placed in Class III injury to crown and Class 6 Dunning's Tree Classification in the preliminary survey of the burn. On October 25, 1929, an attack by las piceae started in the upper portion of the tree and reaching to within 12 feet of the ground. The lower 12 feet was attacked on September 8, 1929, by the western pine beetle. An examination of the base of the tree on September 8, showed it to be in Class III injury to root collar.

Tree No. 550 was placed in Class II fire injury to crown and Class 6 Dunning's Classification in the preliminary survey. The tree was leaning badly and the outer bark on the lower bole was scorched black. After being attacked by Dendroctonus brevicornis, the root collar was examined and found to be 50% scorched by the fire.

Tree No. 939 was placed in Class 3 fire injury to crown and Class 6 Dunning's Classification. An examination of the base of the tree after being attacked, placed it in Class V injury to root collar.

INSECTS ASSOCIATED WITH D. BREVICORNIS IN YELLOW PINE
(TURNER'S HILL BURN)

Table 7

INSECT SPECIES	Tree No.	No. of sq. ft. Bark	Total No. of Insects	Avg. No. per sq. ft.
Clerid larvae	207	20	61	3.1
	550	15	34	2.2
	939	16	11	.7
Tenebrionid larvae	207	20	4	.2
	550	15	19	1.2
	939	16	4	.25
<i>Acolium longum</i> Ad.	207	20	459	21.
	550	15	115	7.6
	939	16	142	9.
<i>Hypophloeus parallelus</i> Ad.	207	20	65	4.25
	550	15	22	1.4
	939	16	43	
Overwintering <i>Ips</i> <i>oregoni</i> Ad.	207	20	358	18.
	550	15	73	4.8
	939	16	226	14.1
<i>Lasconotus subcostatus</i> Ad.	207	20	22	1.1
	550	15	29	2.
	939	16	30	1.8
<i>Lasconotus</i> sp. Ad.	207	20	703	35.
	550	15	316	21.
	939	16	374	23.3
Cecidomyiidae larvae	207	20	1819	91
	550	15	1309	87
	939	16	628	41

Tree No. 207, while having the largest sample of bark, shows next to the lowest number of emerging D. brevicornis. However, this tree had the largest number of associated insects present, and their activities may help account for the reduction of the brood.

Considering the large number of predaceous enemies present in all the infested bark, a very great per cent of increase occurred. The decrease in number of trees attacked on the burn may be partially accounted for by a heavy flight mortality. No data is available for this vicinity on the complete summer generation of the western pine beetle.

INSECT CONDITIONS ON AREA SURROUNDING BURN

The burned area on Tubb's Hill is surrounded on two sides by a good stand of mostly mature yellow pine. For eleven years prior to the fire the area adjacent to the burn had a yearly loss of 3.3 trees killed by the western pine beetle, and 11.7 trees killed by Ins. arizoni. No insect losses on the surrounding area has been recorded since the occurrence of the fire. The attractive value of the fire scorched trees may have drawn all insect activity within the confine of the burn.

SUMMARY

A brief summary of the Tubb's Hill burn for 1930 shows a marked decline in barkbeetle activity. The attacks by the mountain pine beetle have dwindled to a few small severely fire damaged trees. These only being lightly attacked on the lower bole.

The western pine beetle shows a decrease of 50% from the preceding year, and the number of marked fire injured trees attacked by Ins. arizoni shows a decrease of 61 per cent.

There are still a large number of fire injured trees available for insect attack on the burn. Very little change was noted in the general condition of the unattacked fire scorched trees in the different classes of fire injury. It is possible that a number of the trees in Classes IV and V (Table 1) may show some effects in 1931 of the past two unusual dry seasons.

Respectfully submitted,

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